



# **Fiber Optic Distributed (Acoustic) Sensing Technologies for Safety and Security**

İbrahim ÖLÇER

Apr 19, 2023, Porto

# Outline

Introduction

DAS Concept Validation & System Development -  
The FOTAS™ Project

Distributed Sensing for Structural Monitoring –  
The SIMONE™ Concept

Q&A



# INSIGMA Engineering



❑ **Founded in Sep 2020** with the Entrepreneurship Support Program and of TÜBİTAK (The Scientific and Technological Research Council of Türkiye)

❑ **Center Office located in Gebze**  
**R& D Office located in İstanbul**

## ❑ **Vision**

Develop original solutions to disseminate "fiber optic sensor" technologies for diverse industrial applications.

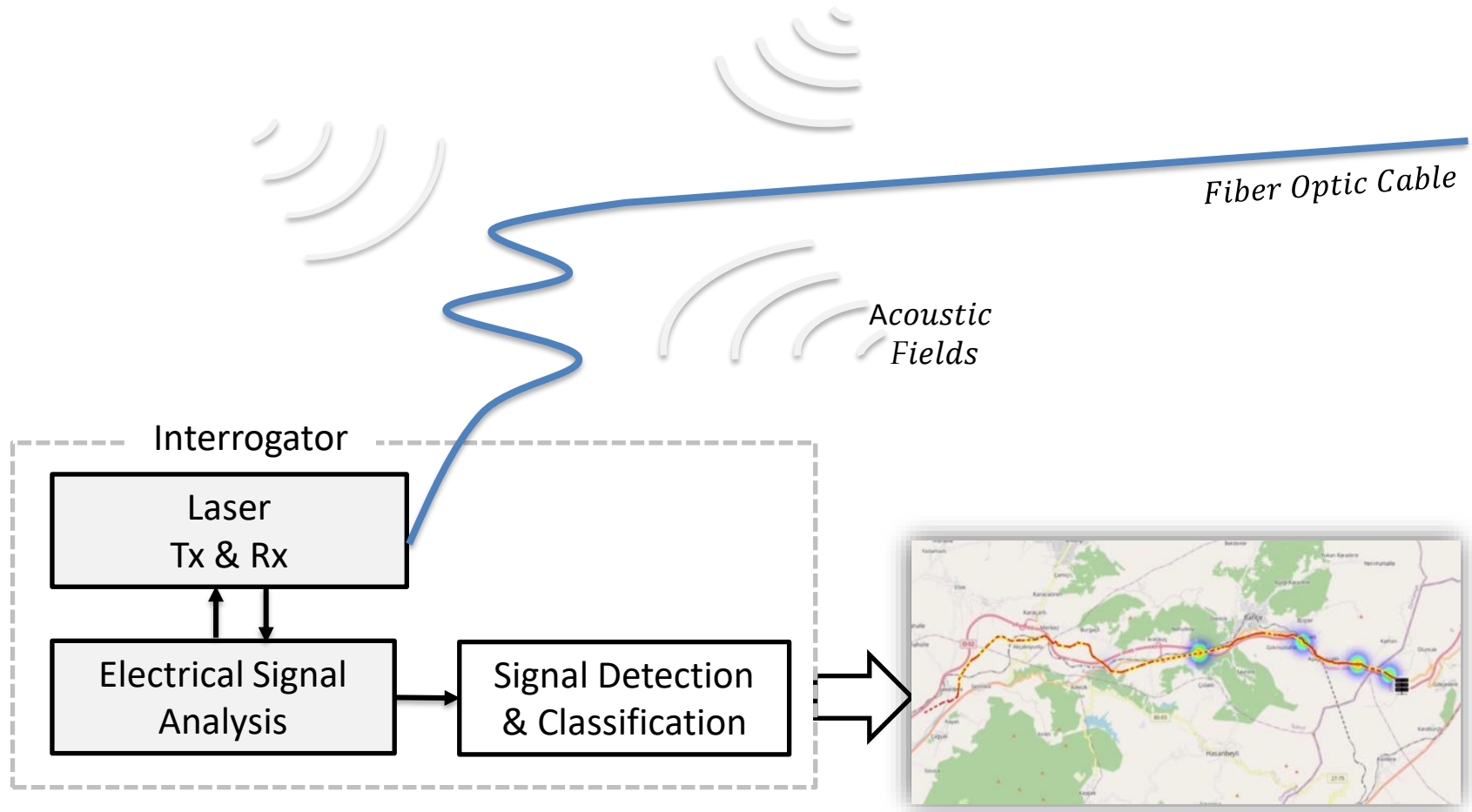
## ❑ **Mission**

Conduct R&D projects as a driving force by raising competent manpower in the field of photonic design and development, focused on scientific developments and innovation.



# Distributed Acoustic Sensing (DAS)

- ❑ Fiber optic cables can be turned to an array of virtual acoustic microphones

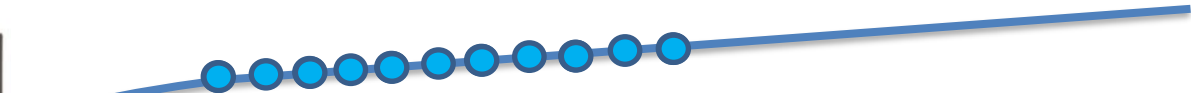


# DAS R&D – The FOTAS™ Project



- ❑ A real DAS system development based on optical time-domain reflectometry (OTDR) started in Feb 2016

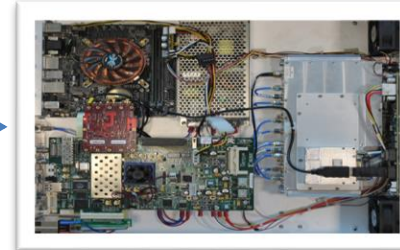
FOTAS Prototype



● Measurement Point



**Optical Front-End**  
Coherent laser  
Modulator  
Photo-detector



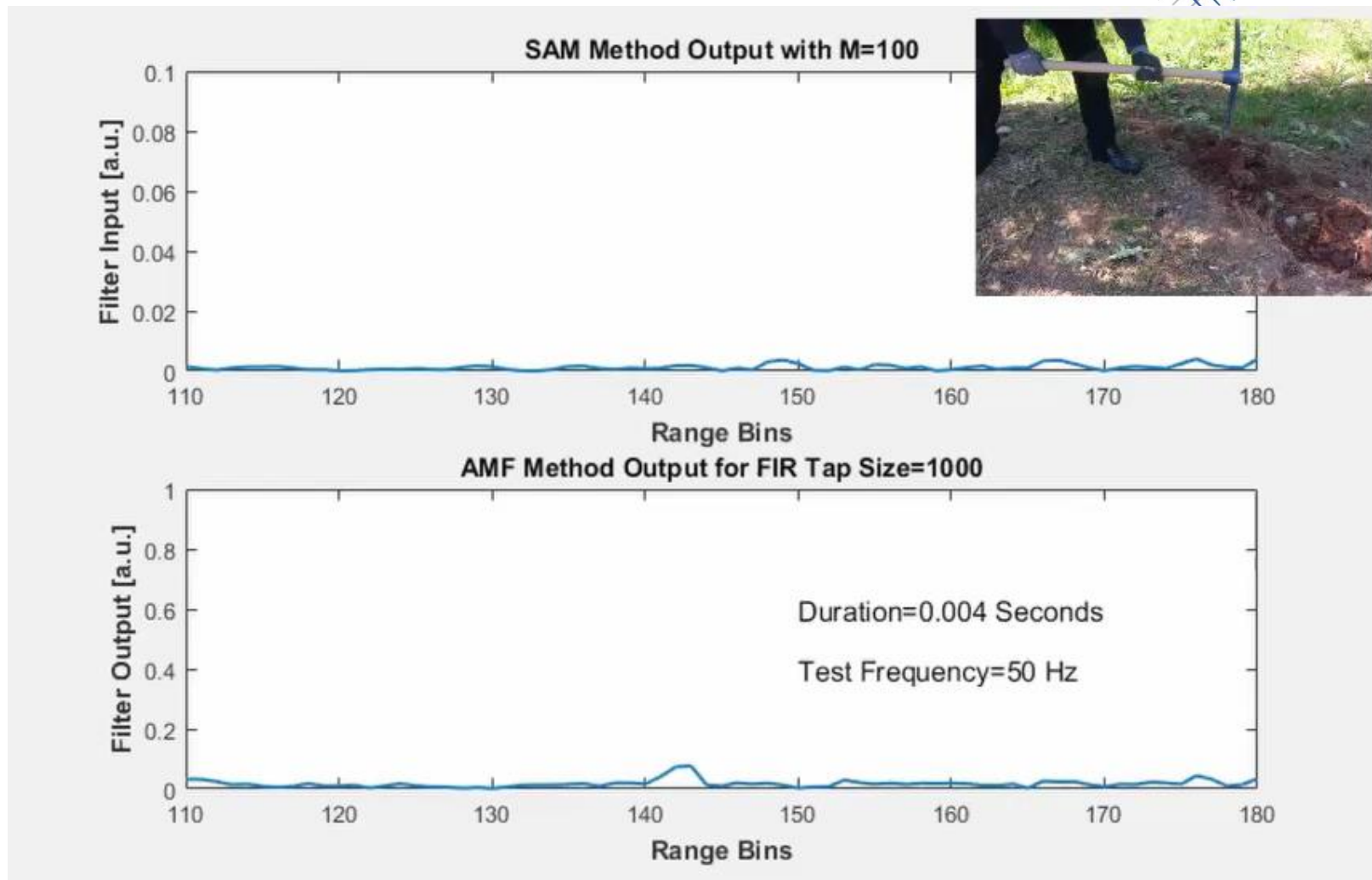
**Software-Defined Radio**  
RF Front-End  
ADC/DAC  
FPGA processing



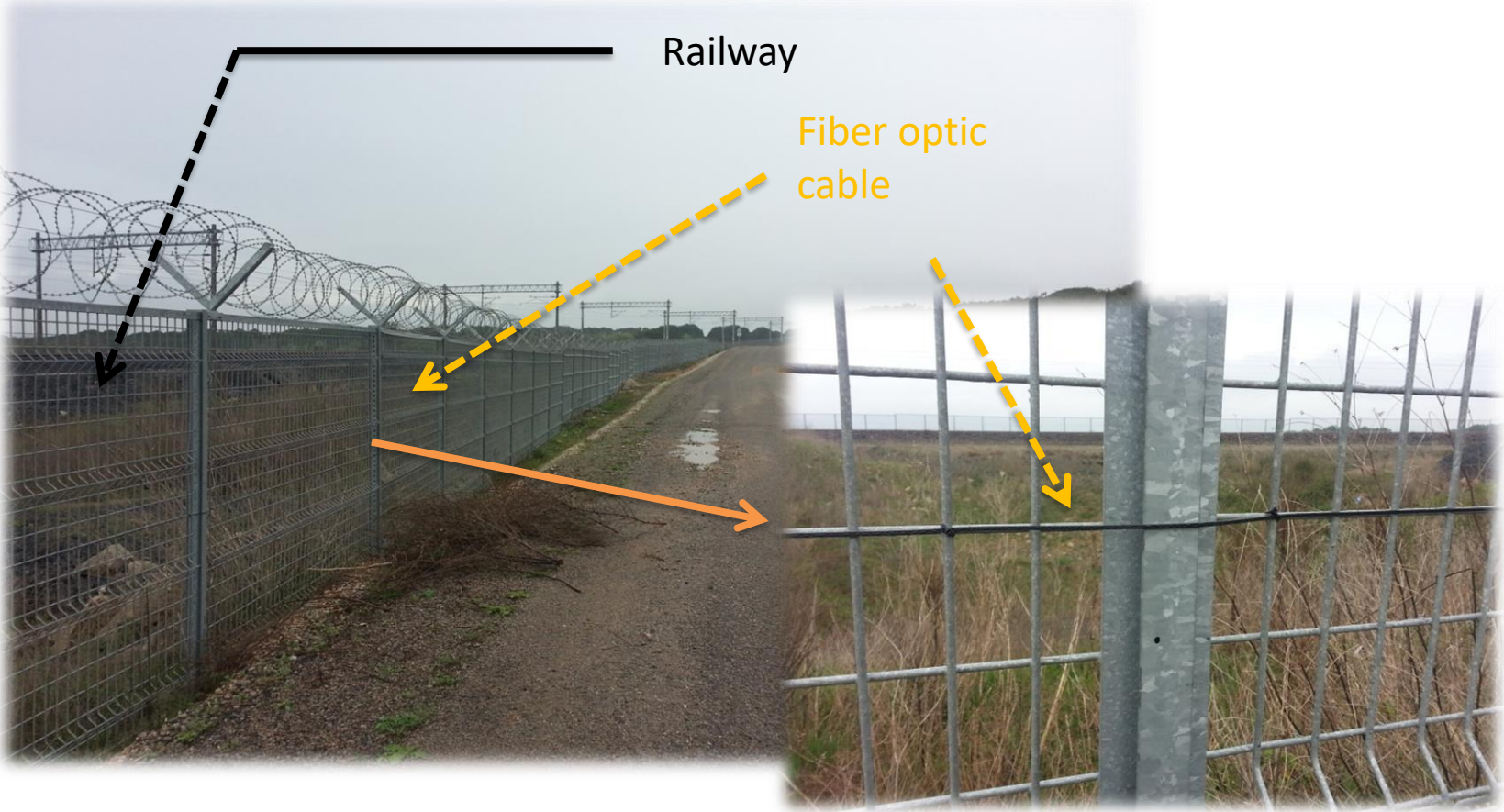
# DAS Validation – Field Tests



# DAS Validation – Field Tests



# DAS Validation – Field Tests

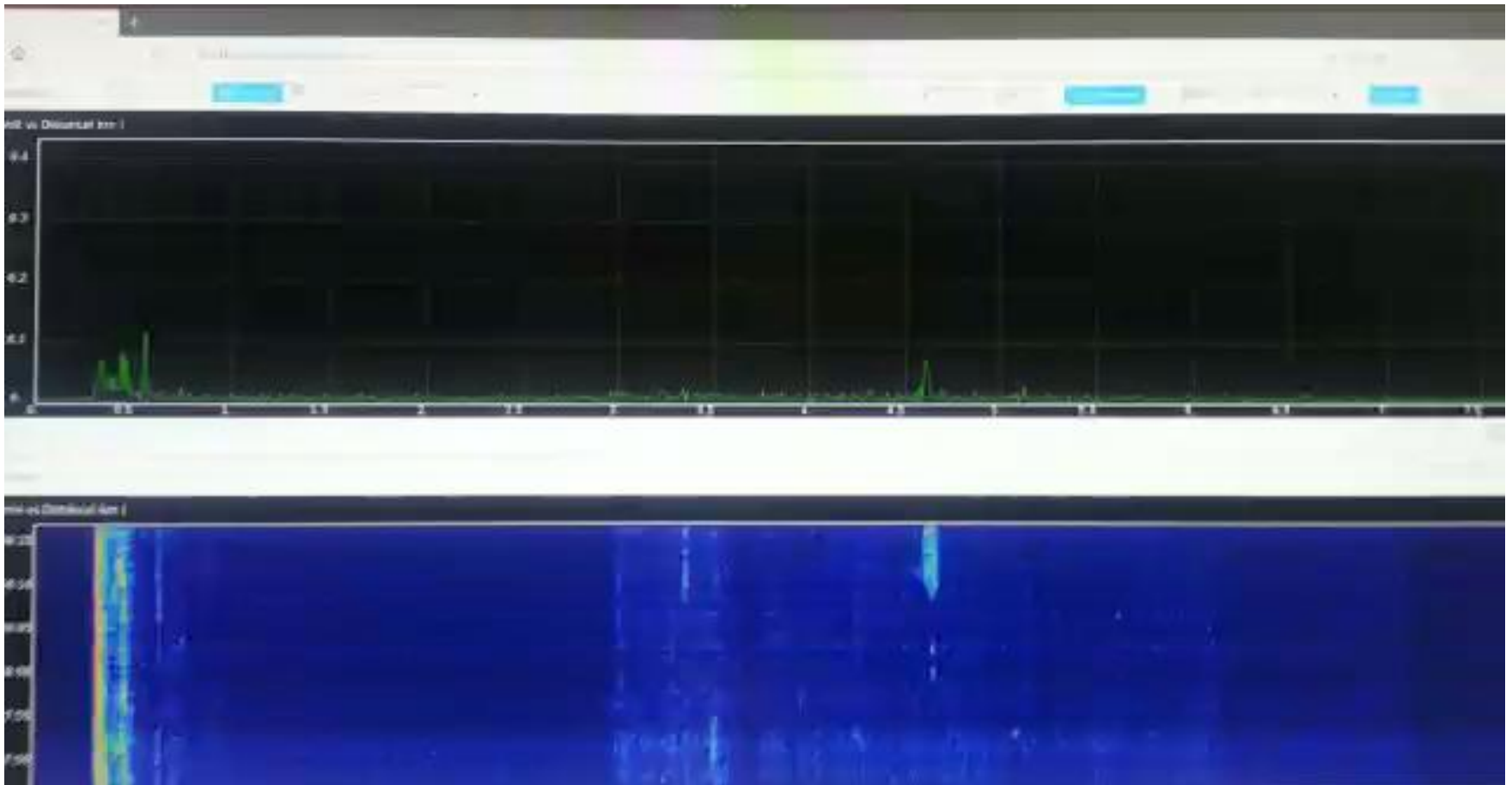




# DAS Validation – Field Tests



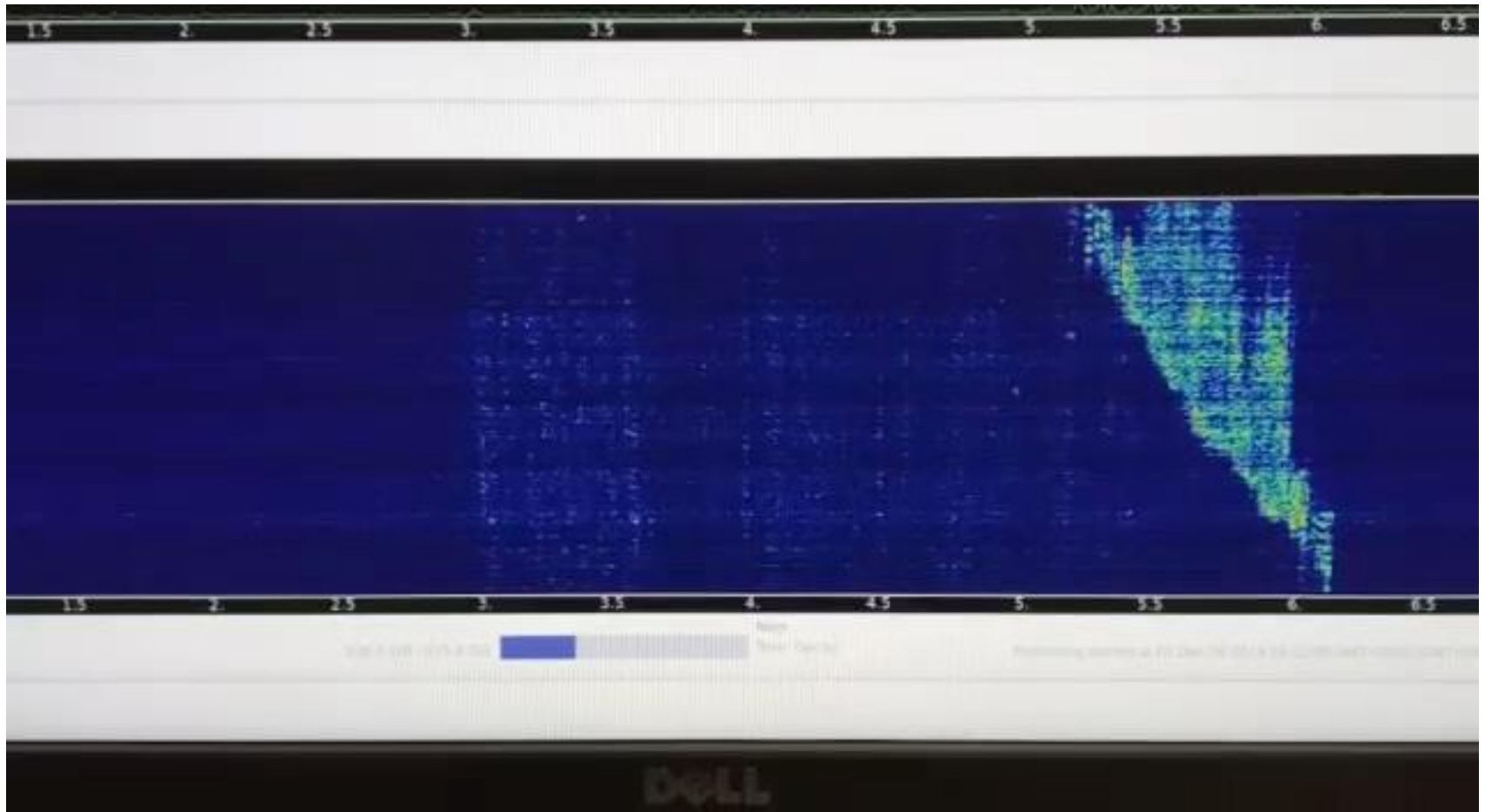
## Man-Made Activities / Fence Climbing Example



# DAS Validation – Field Tests

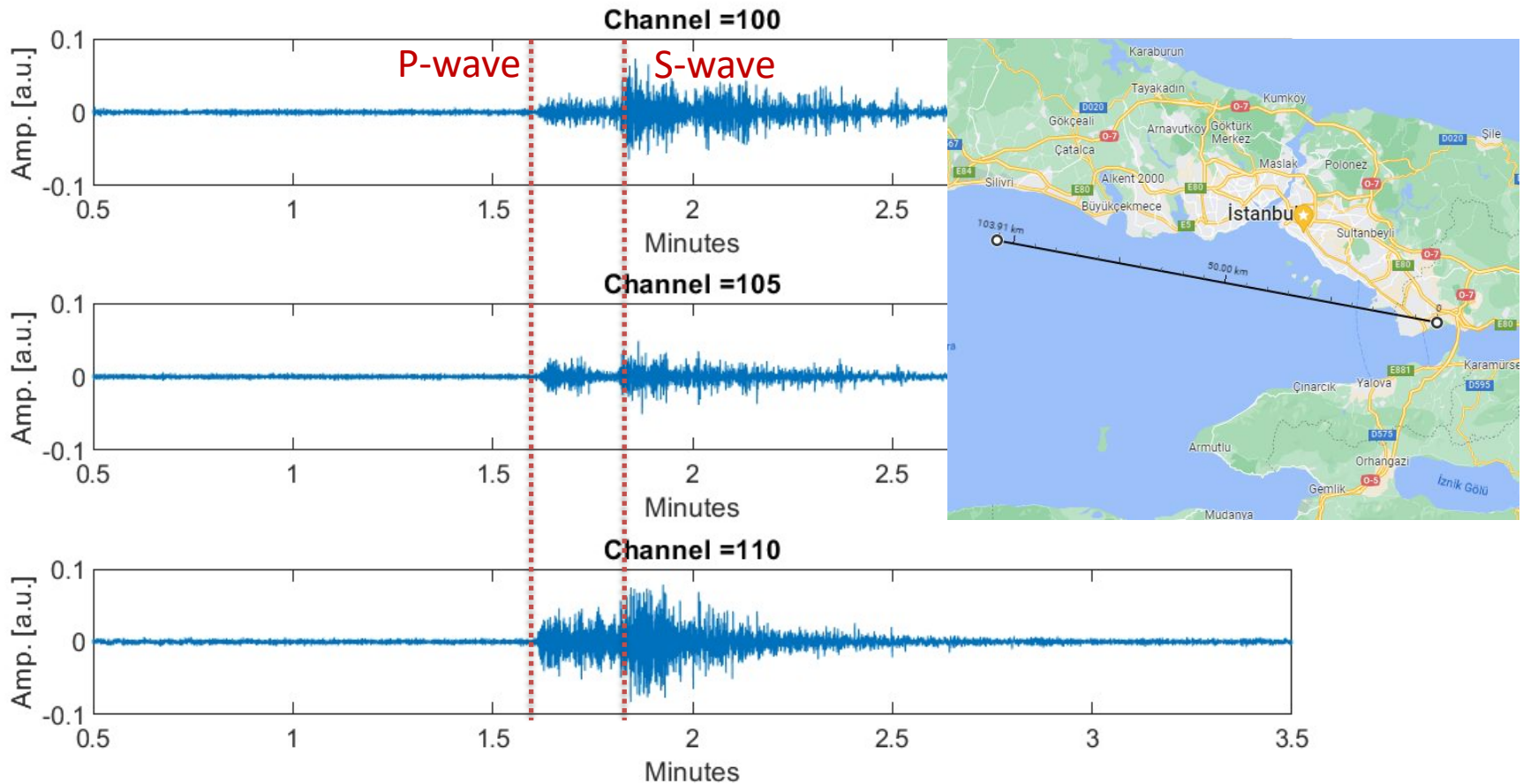


## ❑ High-Speed Train Tracking



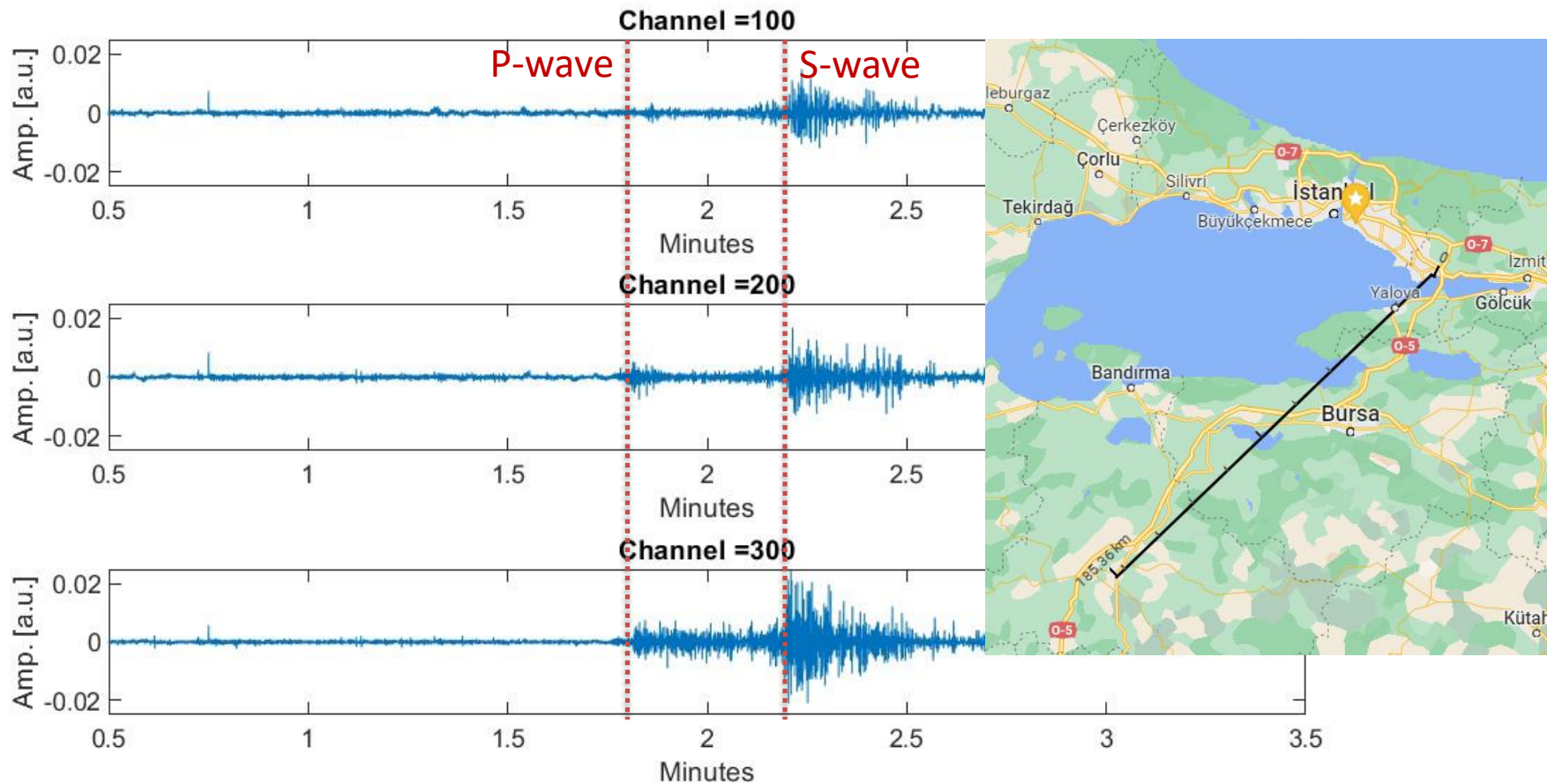
# DAS for Earthquake Detection

## Earthquake Detection - M5.7 Silivri (18 Oct 2019)

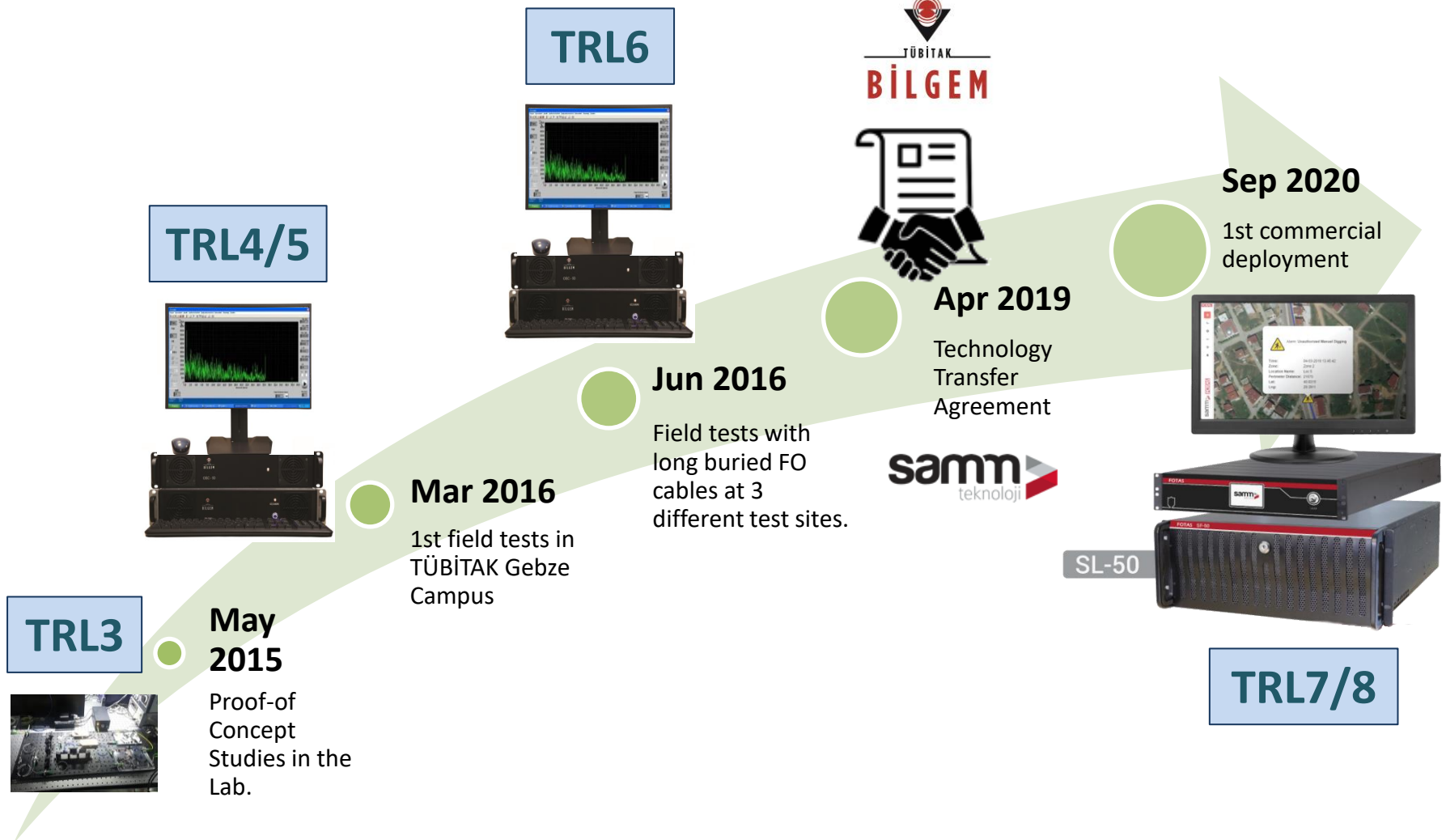


# DAS for Earthquake Detection

## Earthquake Detection - M4.9 Balıkesir (13 Dec 2019)



# Technology Evaluation of FOTAS™



# DAS for Perimeter Security

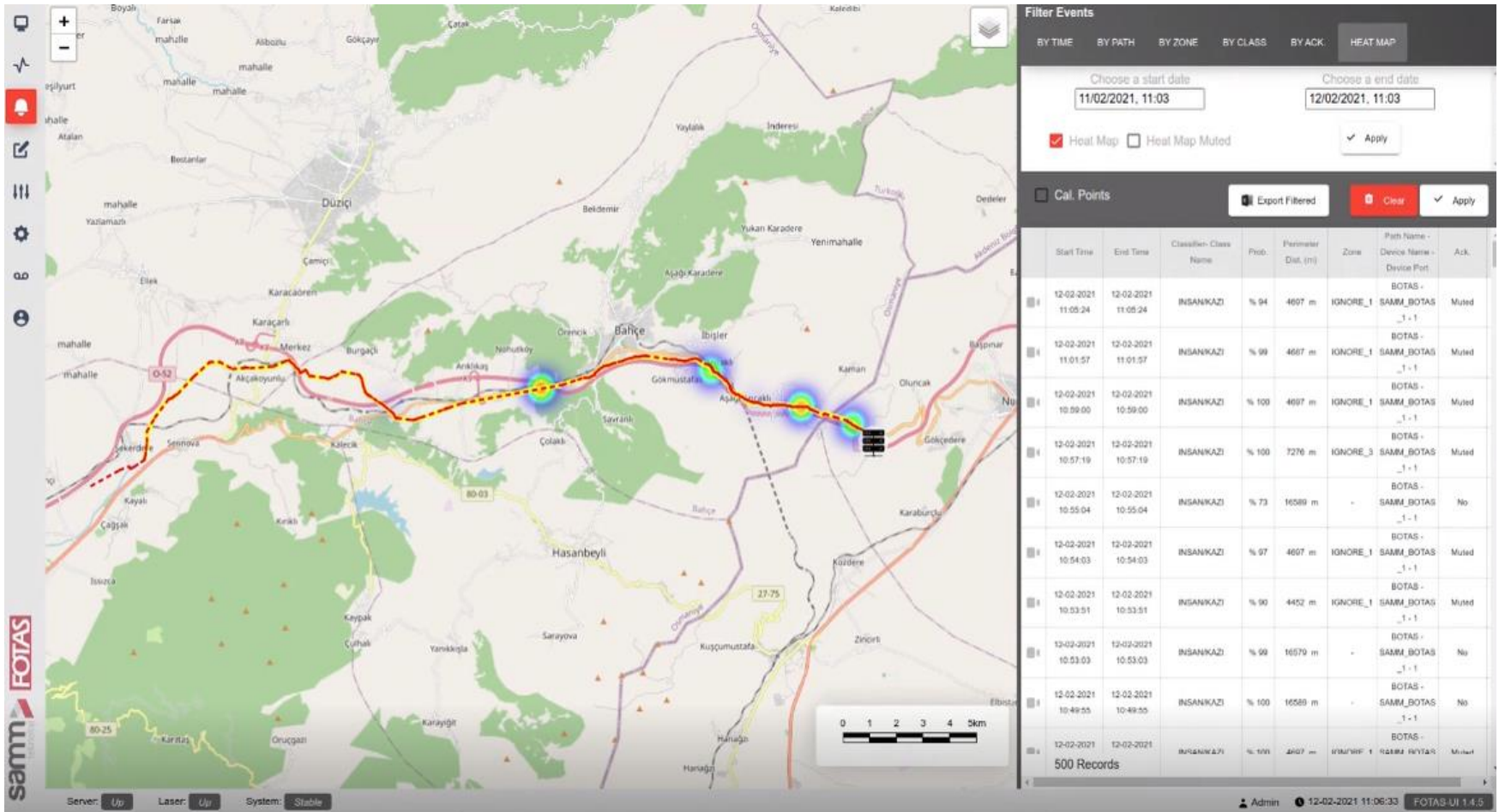


<https://www.linkedin.com/company/sammteknoloji/videos/>

<https://bilgem.tubitak.gov.tr/tr/haber/kritik-tesislerin-cevre-guvenliginde-fiber-optik-tabanli-guvenlik-sistemleri-kullanilacak>



# DAS for Pipeline Security



# Vibration SIMONE™ Project



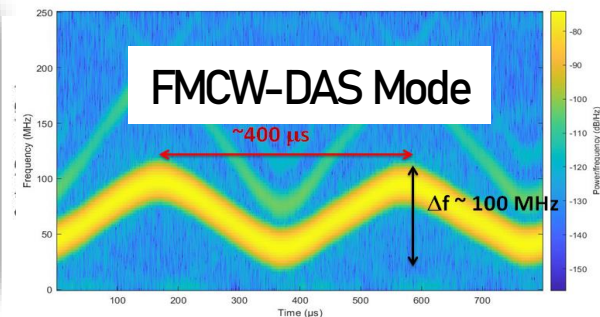
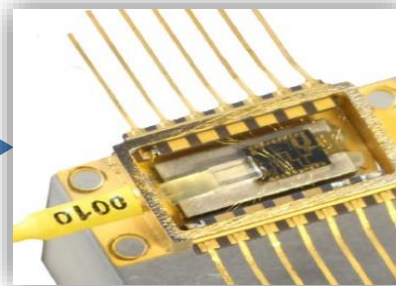
- ❑ Commenced in Dec 2020 for test and evaluation of optical frequency domain reflectometry (OFDR) based DAS for structural health monitoring (SHM)
- ❑ TRL4/5 products demonstrated with «swept-wavelength laser» technology



**VS-80Q**  
FBG Interrogator  
Dynamic Interrogator



**VS-100FQ (Dual-Mode)**  
FBG/DAS Interrogator



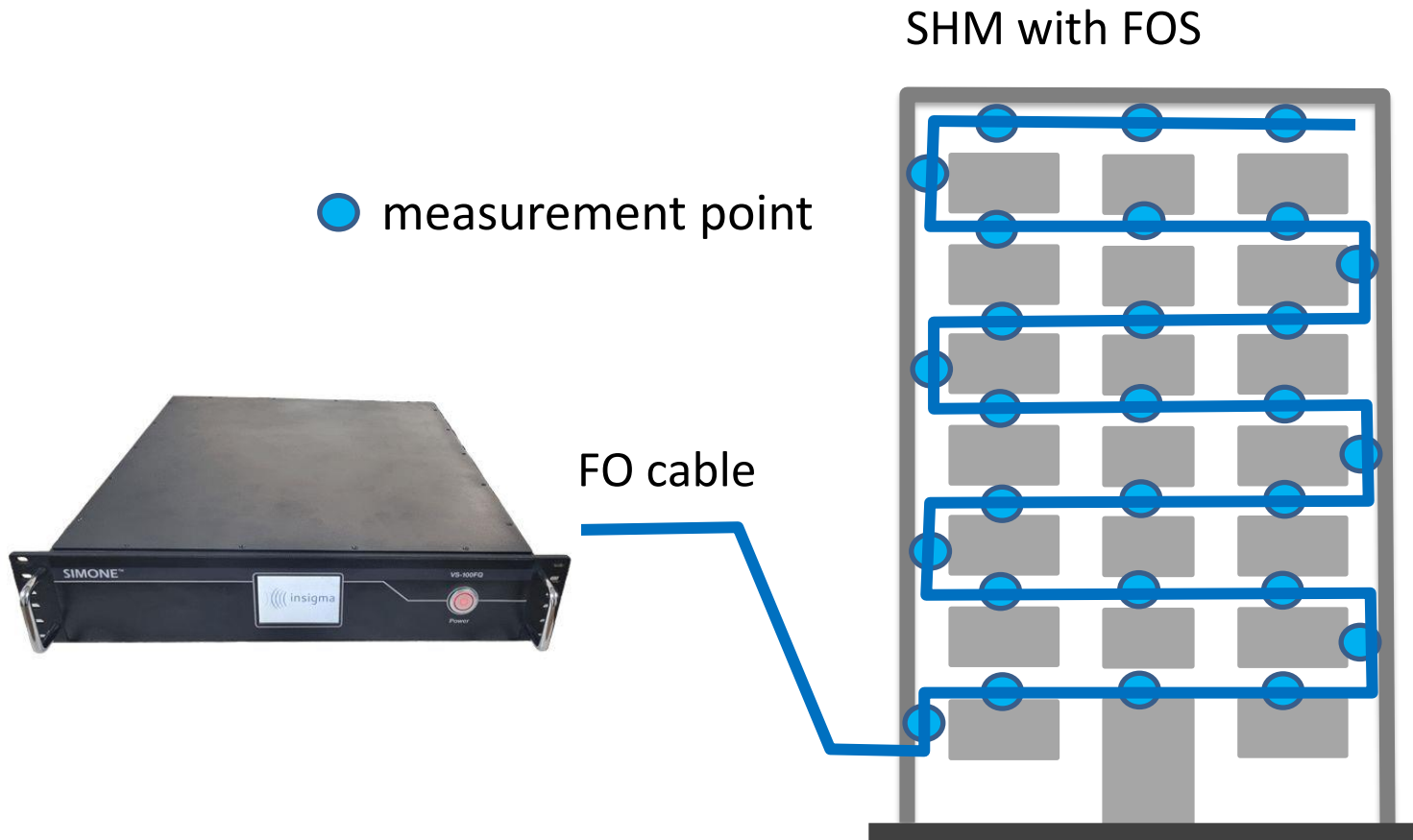




# SIMONE™ for Civil Structures



- ❑ DAS concept to replace conventional sensors for structural monitoring.



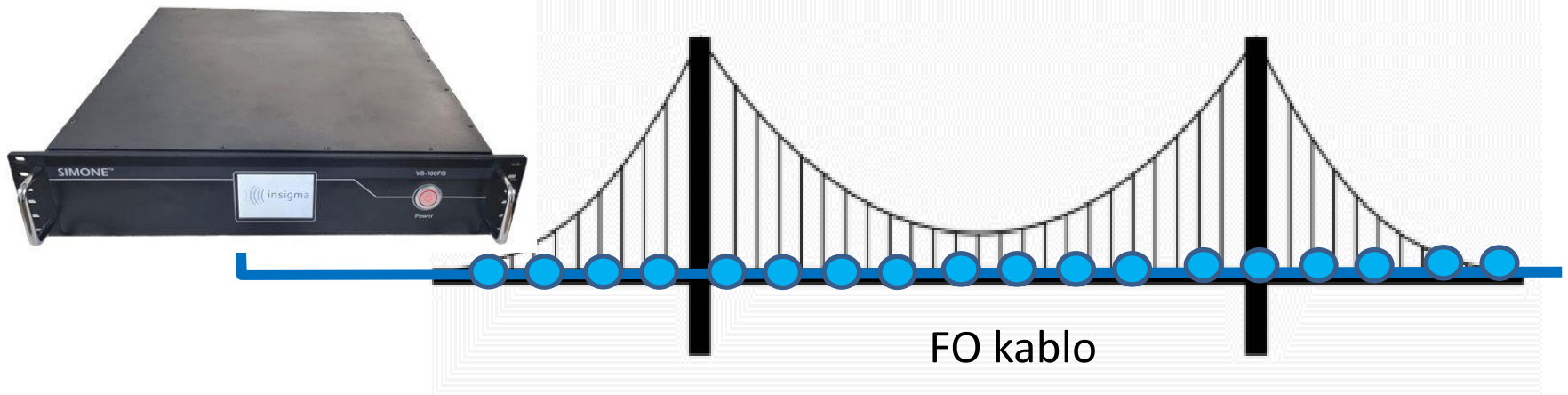
# SIMONE™ for Civil Structures



- ❑ Distributed FOS solution for dams, bridges, etc.

## SHM with FO cables for bridges

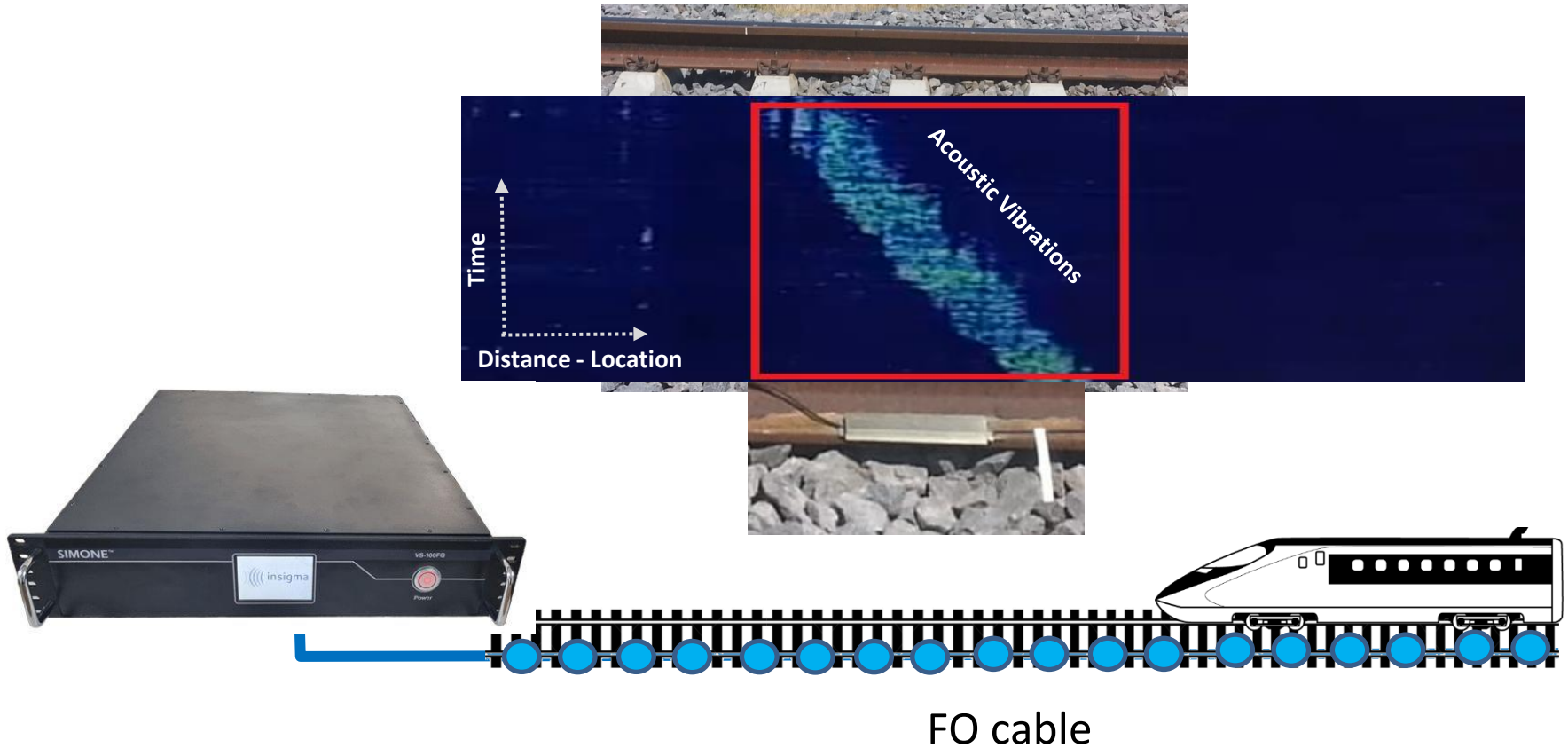
● measurement point



# SIMONE™ for Railways



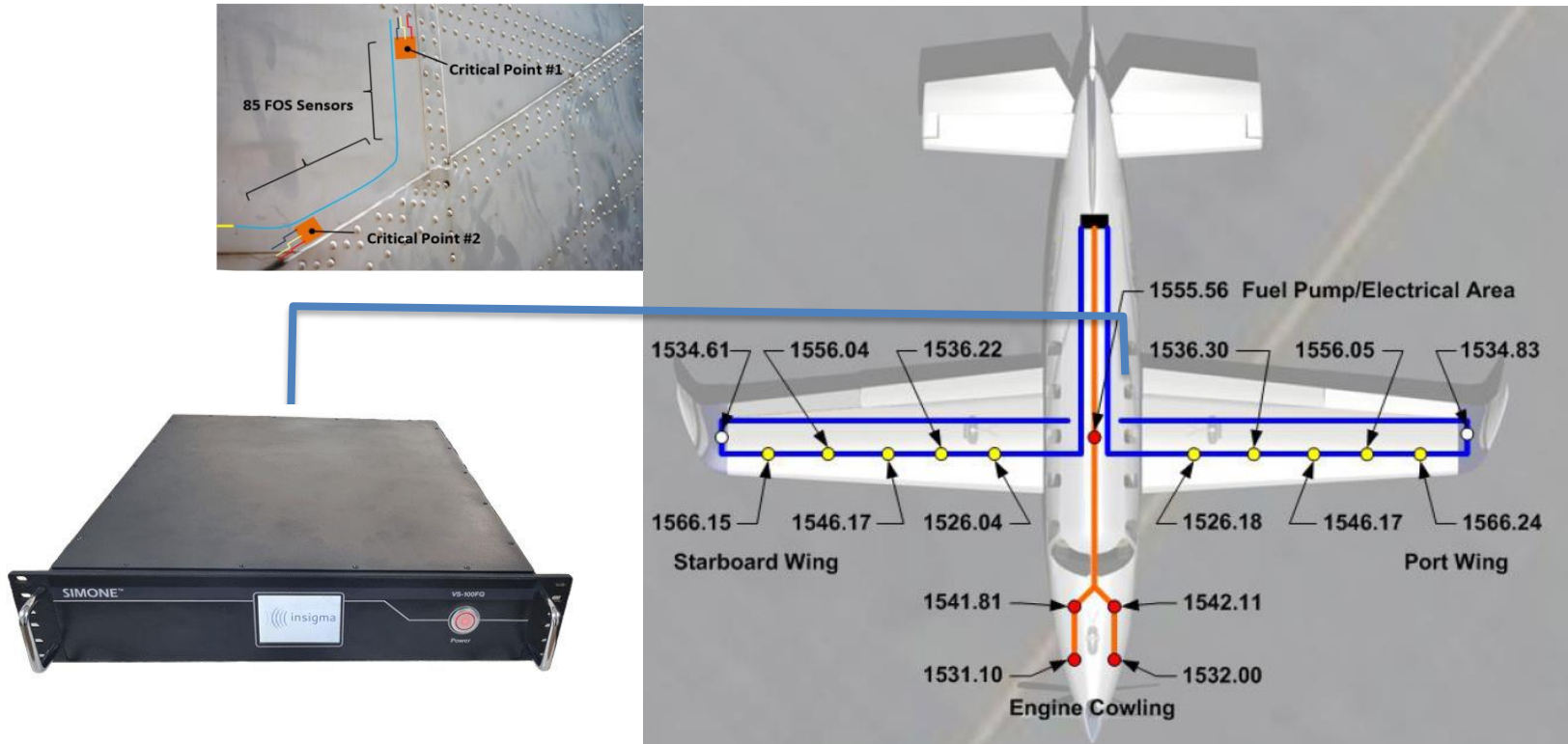
- Railway infrastructure can be used for monitoring and tracking trains.



# SIMONE™ for Aerostructures



- ❑ Scalable spatial resolution for aerospace requirements (strain mapping)



# Remarks on DAS Technology



- Promising and unique for monitoring critical infrastructure and environment with field proven OTDR-DAS scheme.
- «**Photonic Seismology**» is another emerging research field for earthquake preparedness which will yield invaluable data in the long-term.
- Low false-alarm rate (FAR) is critical factor for security related applications.
- Low-cost SHM solutions is critical for widespread use in the public safety domain.

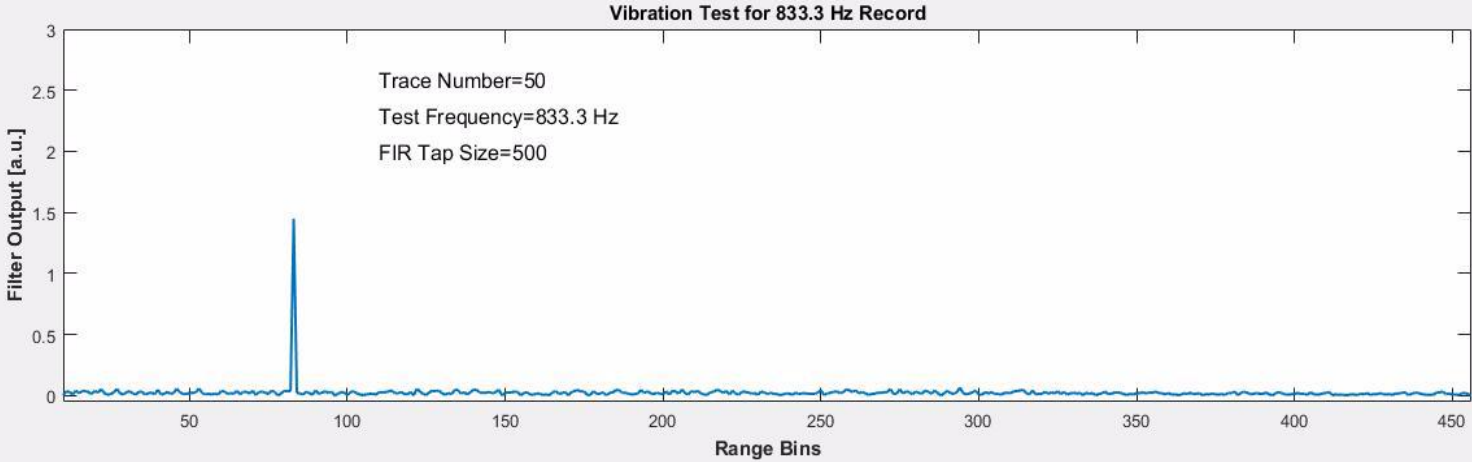
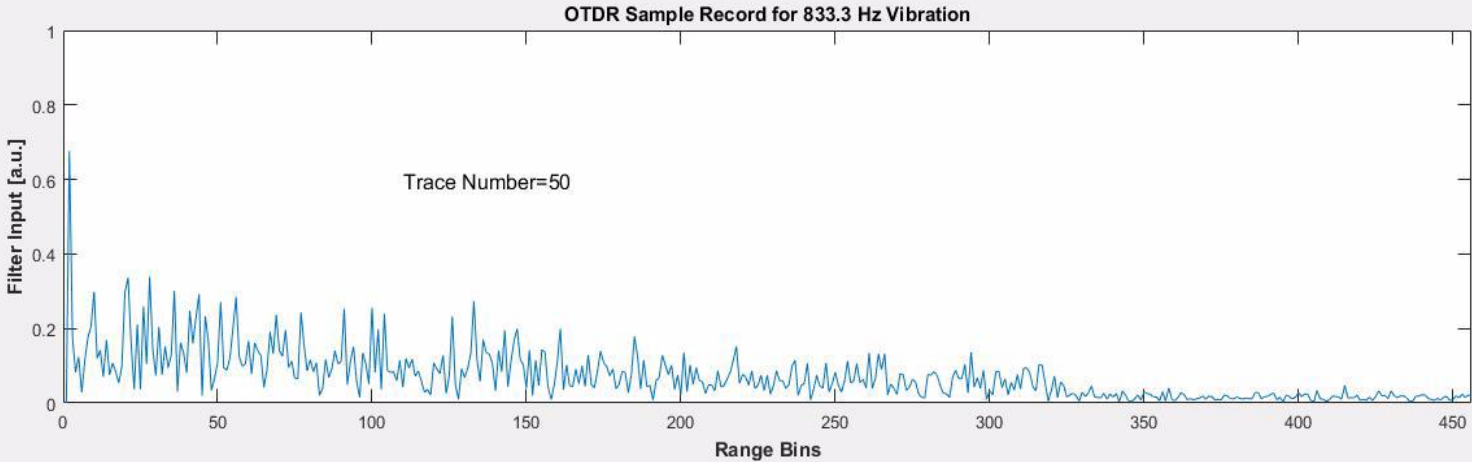


# Thank You



Listen to the Silence,  
and feel the Safety  
with SIMONE™

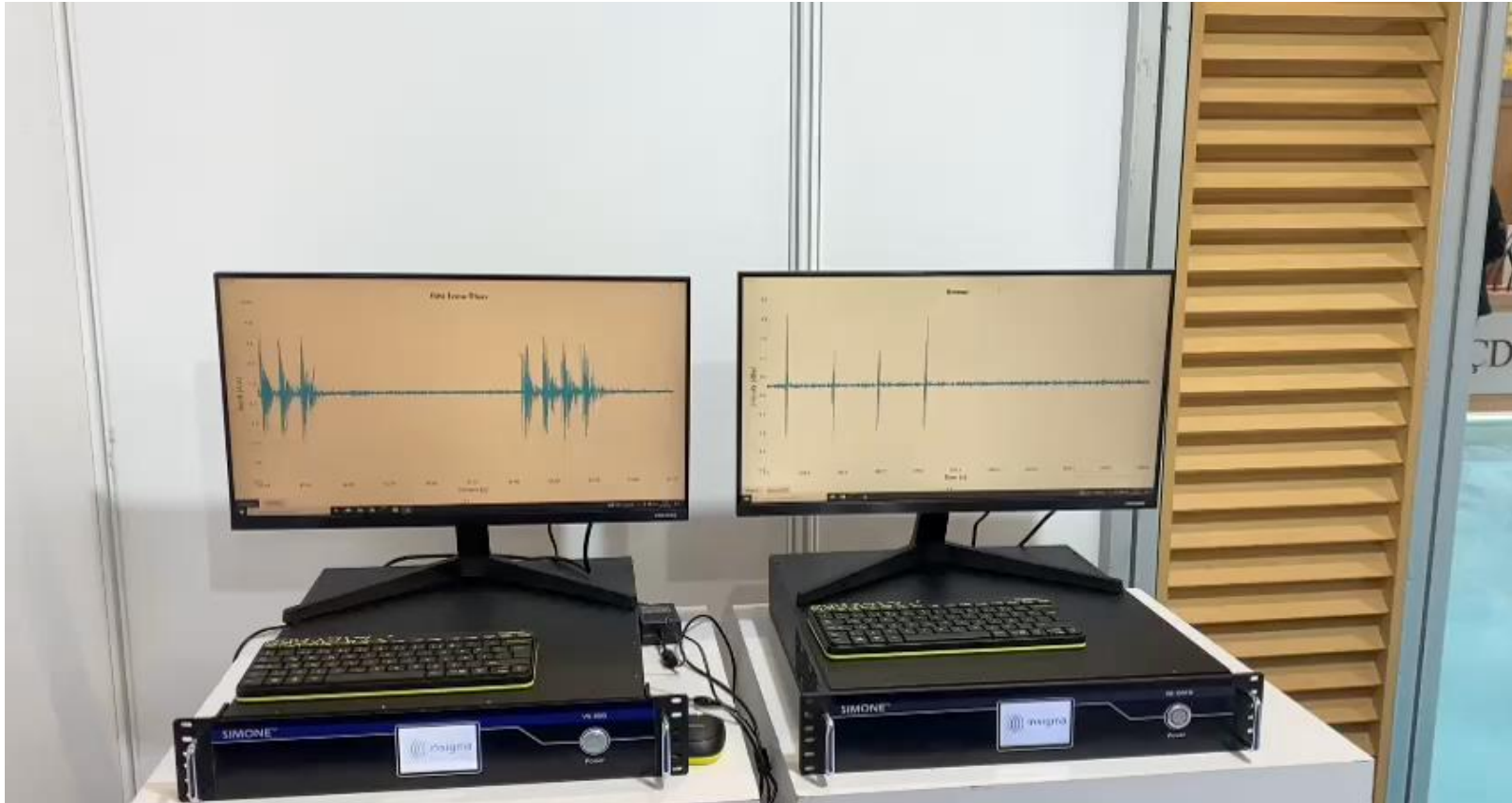
# Vibration Test with Indoor Setup





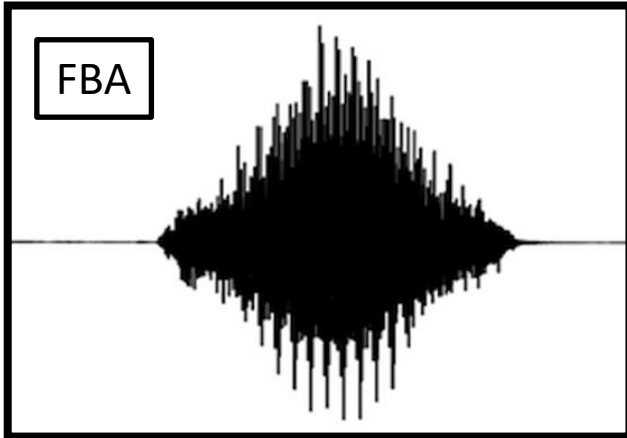
# SIMONE™ for SHM

- ❑ FBG Interrogator vs OFDR-DAS Interrogator



# SIMONE™ for SHM

## ❑ FBA Accelerometer vs OFDR-DAS Interrogator



Sample vibration test result in the SHM lab of  
Gebze Technical University

